

MESOSCALE CIRCULATION AND PRIMARY PRODUCTION IN EASTERN BOUNDARY CURRENT SYSTEMS

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LONG-TERM GOALS

The long-term goals of this project are to: (1) improve our ability to measure the patterns of primary production and phytoplankton abundance in the ocean, (2) understand what causes these patterns and (3) improve our predictive ability.

SCIENTIFIC/TECHNICAL OBJECTIVES

Observation of the patterns of primary production and phytoplankton abundance is hindered by the difficulties in sampling caused by the great spatial and temporal variability in the ocean. We are attempting to better resolve spatial pattern by using a continuous underway mapping system, and temporal pattern by using shore-based sampling of proxy variables and model output to fill in the gaps between shipboard surveys. We have shown that physical structure which determines the nutrient distribution and advection are the two main determinants of phytoplankton abundance in the California Current. We are now attempting to determine which specific aspects of physical structure have the most direct effect upon phytoplankton abundance. Prediction is hindered by our ability to predict either physical or biological structure, and by our limited understanding of how physical and biological structure are linked. We expect that progress will come most rapidly in predicting physical structure. We are thus attempting to predict the patterns of phytoplankton given predictions of physical structure.

APPROACH

Analysis of continuous underway data has focused upon testing predictions based upon the expected linkages between physical and biological structure (e.g., the temperature-nitrate relation and the temperature-chlorophyll relation). The finding of some unexpected patterns (e.g., high chlorophyll at temperatures where nitrate is not expected to be present) has led to a better understanding of the regional nature of the linkages between physical and biological structure. Analysis of historical data in order to

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determine what patterns should be expected has indicated that the linkages between physical and biological structure also depend upon the temporal scale of physical forcing. This analysis has focused upon mesoscale, seasonal, and interannual to decadal scale forcing. It is not clear that linkages determined on one space-time scale will apply to others, and we are determining to what extent linkages are scale dependent. Initial attempts at improving our predictive ability are based upon making predictions prior to cruises and evaluating the predictions following the cruises.

TASKS COMPLETED

We have completed development of a data processing scheme for the continuous underway mapping system and have improved the reliability of data logging software. Work is continuing on a data management scheme and processing data from past cruises. A manuscript on the continuous underway data and linkages between physical and biological structure has been submitted. We have provided interpretation of CalCOFI and other regional data in support of ONR projects collaborating with the CalCOFI program. We completed processing the data from the enhanced CalCOFI cruise on RV Roger Revelle as well as other CalCOFI cruises and have distributed the data to ONR-supported Pis. We have gathered the historical chlorophyll data from the California Current region for comparison with the hydrographic and macrozooplankton time series.

RESULTS

Analysis of a 4-year time series of the continuous underway data in the context of the hydrographic data shows that there is a variable relation between nearsurface physical structure (temperature, salinity) and chlorophyll in different subregions of the California Current. The boundaries of these subregions (regimes) can be identified based upon physical structure. Analysis of the hydrographic data gives insights into the differing types of physical forcing which determine phytoplankton abundance in each subregion. Analysis of the chlorophyll time-series does not show the same large decline since the mid-1970s as has recently been documented for macrozooplankton biomass. Although the chlorophyll time series has many fewer data points and it is not as long as the macrozooplankton time series (chlorophyll began as a routine measurement in 1984), this leads to the question of whether climate change affects the lower trophic levels in the California Current via bottom-up forcing.

IMPACTS

The observation that nearsurface physical-biological coupling is region specific and that the boundaries between regions can be identified based upon physical structure, means that it may be possible to start developing region-specific models linking physical and biological structure. Uncertainty about whether the decline in macrozooplankton biomass is due to bottom-up forcing further illustrates the need to better understand the processes linking physical and biological structure.

TRANSITIONS

A major objective of this project is identify those specific aspects of physical structure which can be modeled or remotely sensed which have the most predictive value about the phytoplankton distribution. Identifying these properties should have value in focusing observational and modeling efforts in support of biological objectives and in improving our ability to describe and predict biological structure.

RELATED PROJECTS

This project is strongly interconnected with several other projects supported by ONR and other federal and state agencies. The CalCOFI program provides the sampling opportunity to collect the continuous underway data and much of the supporting data used in this analysis. We are also using realtime output from the Navy NODDS model and exploring the use of other data sets which may become available. This project has provided background information for several other ONR supported projects which are collaborating with CalCOFI (Bucklin, Goericke, Haury, Mitchell, Wiebe) as well as projects supported by other federal agencies. This project will benefit from additional higher frequency sampling planned for 1997 and 1998 by the CalCOFI program to study the effects of ENSO conditions in the California Current.